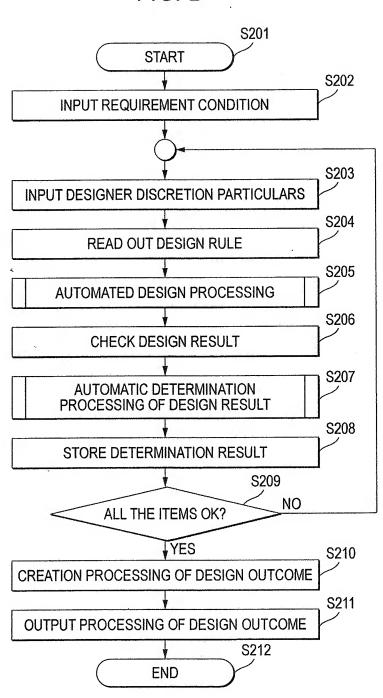Appl. No. 10/566,705
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FIG. 1

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FIG. 2

START — S201

INPUT REQUIREMENT CONDITION — S202

INPUT DESIGNER DISCRETION PARTICULARS — S203

READ OUT DESIGN RULE — S204

AUTOMATED DESIGN PROCESSING — S205

CHECK DESIGN RESULT — S206

AUTOMATIC DETERMINATION PROCESSING OF DESIGN RESULT — S207

STORE DETERMINATION RESULT — S208

ALL THE ITEMS OK? — S209 — NO

YES

CREATION PROCESSING OF DESIGN OUTCOME — S210

OUTPUT PROCESSING OF DESIGN OUTCOME — S211

END — S212

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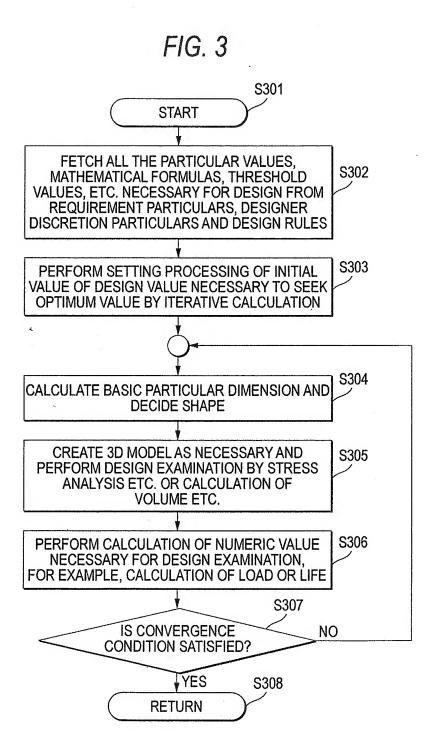Filed on September 29, 2006
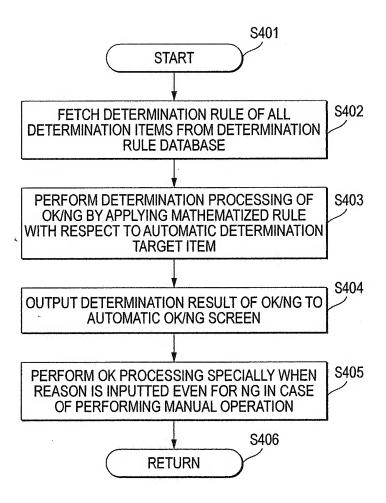Replacement Sheet

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FIG. 3

```
                    ┌──────────┐  S301
                    │  START   │
                    └────┬─────┘
                         │
         ┌───────────────▼─────────────────┐
         │ FETCH ALL THE PARTICULAR VALUES, │ S302
         │ MATHEMATICAL FORMULAS, THRESHOLD │
         │ VALUES, ETC. NECESSARY FOR DESIGN│
         │ FROM REQUIREMENT PARTICULARS,    │
         │ DESIGNER DISCRETION PARTICULARS  │
         │ AND DESIGN RULES                 │
         └───────────────┬─────────────────┘
                         │
         ┌───────────────▼─────────────────┐
         │ PERFORM SETTING PROCESSING OF    │ S303
         │ INITIAL VALUE OF DESIGN VALUE    │
         │ NECESSARY TO SEEK OPTIMUM VALUE  │
         │ BY ITERATIVE CALCULATION         │
         └───────────────┬─────────────────┘
                        (○)◄──────────────────┐
                         │                    │
         ┌───────────────▼─────────────────┐  │
         │ CALCULATE BASIC PARTICULAR       │ S304
         │ DIMENSION AND DECIDE SHAPE       │  │
         └───────────────┬─────────────────┘  │
                         │                    │
         ┌───────────────▼─────────────────┐  │
         │ CREATE 3D MODEL AS NECESSARY AND │ S305
         │ PERFORM DESIGN EXAMINATION BY    │  │
         │ STRESS ANALYSIS ETC. OR          │  │
         │ CALCULATION OF VOLUME ETC.       │  │
         └───────────────┬─────────────────┘  │
                         │                    │
         ┌───────────────▼─────────────────┐  │
         │ PERFORM CALCULATION OF NUMERIC   │ S306
         │ VALUE NECESSARY FOR DESIGN       │  │
         │ EXAMINATION, FOR EXAMPLE,        │  │
         │ CALCULATION OF LOAD OR LIFE      │  │
         └───────────────┬─────────────────┘  │
                         │           S307      │
                    ╱────▼────╲          NO    │
                  ╱  IS CONVERGENCE ╲──────────┘
                  ╲  CONDITION SATISFIED? ╱
                    ╲────┬────╱
                         │ YES
                    ┌────▼─────┐  S308
                    │  RETURN  │
                    └──────────┘
```
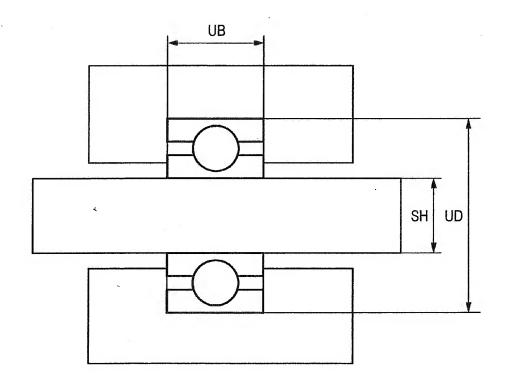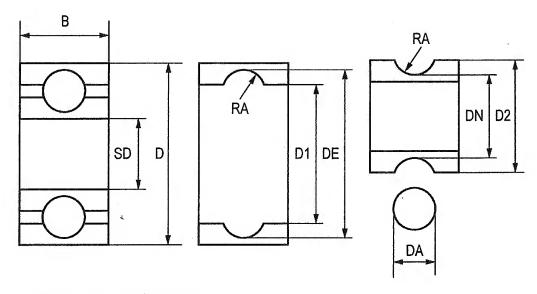
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FIG. 4

S401

START

S402

FETCH DETERMINATION RULE OF ALL
DETERMINATION ITEMS FROM DETERMINATION
RULE DATABASE

S403

PERFORM DETERMINATION PROCESSING OF
OK/NG BY APPLYING MATHEMATIZED RULE
WITH RESPECT TO AUTOMATIC DETERMINATION
TARGET ITEM

S404

OUTPUT DETERMINATION RESULT OF OK/NG TO
AUTOMATIC OK/NG SCREEN

S405

PERFORM OK PROCESSING SPECIALLY WHEN
REASON IS INPUTTED EVEN FOR NG IN CASE
OF PERFORMING MANUAL OPERATION

S406

RETURN

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FIG. 5

UB

SH UD

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FIG. 6

DA = DESIGNER INPUT VALUE

B = HOUSING WIDTH INPUT VALUE

D = HOUSING DIAMETER INPUT VALUE

SD = SHAFT DIAMETER INPUT VALUE

RA = BY CALCULATION FORMULA OF DESIGN RULE DG001

$D1 = (D - SD) * 0.6 + SD$

$D2 = (D - SD) * 0.4 + SD$

$DE = (D + SD) / 2 + DA$

$DN = (D + SD) / 2 - DA$

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FIG. 7

DESIGN RULE EXPANSION	DESIGN VALUE AND PROBLEM AVOIDANCE RULE	ADVICE	BASIS MATERIAL	ITEM ID
BEARING DOES NOT FUNCTION				
GROOVE RADIUS IS IMPROPER	RA = DA * 55 / 100		AA PROVISION 001	DG001
BALL DIAMETER IS TOO LARGE	DA < = (D − SD) / 2 * 0.6	DECREASE BALL DIAMETER	Xx EXPERIMENT 002	DG002
BALL DIAMETER IS TOO SMALL	DA > = (D − SD) / 2 * 0.4	INCREASE BALL DIAMETER	REPORT 034	DG003

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FIG. 8

PROVISION NUMBER: NSK00123
DATE OF EFFECT: 2003/10/30
VERSION: 01-03

DESIGN REFERENCE OF GROOVE RADIUS AND BALL DIAMETER OF BALL BEARING

1. SCOPE OF APPLICATION
   A DESIGN METHOD OF A BALL BEARING DEFINED BELOW SHOULD BE APPLIED TO DESIGN OF BALL BEARINGS FOR GENERAL USE EXCLUDING BALL BEARINGS FOR SPECIAL USE DEFINED SEPARATELY.

2. SCOPE OF BALL DIAMETER (DA)
   DECIDE A BALL DIAMETER SO AS TO SATISFY THE FOLLOWING TWO FORMULAS IN ORDER TO AVOID A PROBLEM THAT THE BEARING DOES NOT FUNCTION.

AVOIDANCE METHOD OF PROBLEM THAT BALL DIAMETER IS TOO LARGE

$$DA <= (D - SD) / 2 * 0.6 \qquad ID = (DG002)$$

AVOIDANCE METHOD OF PROBLEM THAT BALL DIAMETER IS TOO SMALL

$$DA >= (D - SD) / 2 * 0.4 \qquad ID = (DG003)$$

REFERENCE DOCUMENT: Xx EXPERIMENT 002, REPORT 034

3. CALCULATION METHOD OF GROOVE RADIUS (RA)
   CALCULATE GROOVE RADII OF AN OUTER RING AND AN INNER RING BY THE FOLLOWING CALCULATION FORMULA IN ORDER TO AVOID A PROBLEM THAT THE BEARING DOES NOT FUNCTION.
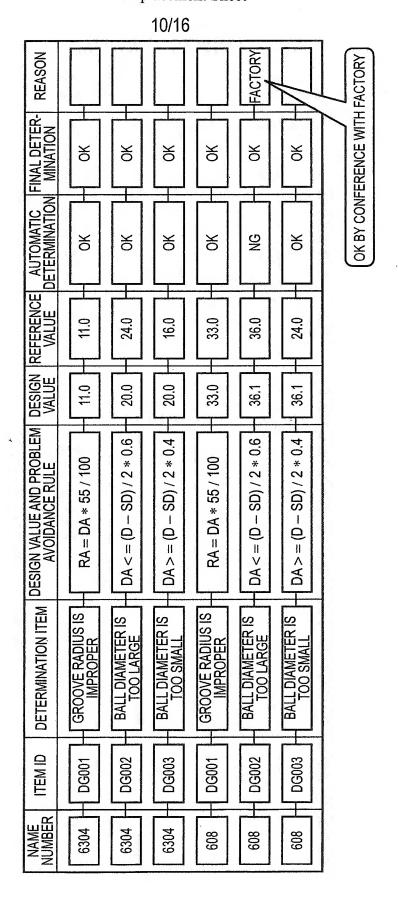
CALCULATION FORMULA IN WHICH GROOVE RADIUS DOES NOT BECOME IMPROPER

$$RA = DA * 55 / 100 \qquad ID = (DG001)$$

REFERENCE DOCUMENT: AA PROVISION 001

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FIG. 9

RULE NAME	DESCRIPTION OF RULE
COMPONENT INVENTORY COOPERATION RULE:	RULE OF, FOR EXAMPLE, PREFERENTIALLY SELECTING COMPONENT WITH A LARGER NUMBER OF INVENTORIES OR PRESENCE OR ABSENCE OF INVENTORY AT THE TIME OF SELECTION OF COMPONENT BUILT IN PRODUCT
PURCHASE COMPONENT SELECTION RULE:	RULE OF, FOR EXAMPLE, SELECTING COMPONENT CAPABLE OF BEING STABLY SUPPLIED, CHEAP COMPONENT FROM AMONG PURCHASE COMPONENTS SATISFYING CONDITIONS OF PRODUCT
MATERIAL SELECTION RULE:	RULE OF, FOR EXAMPLE, SELECTING MATERIAL CAPABLE OF BEING STABLY SUPPLIED, CHEAP MATERIAL FROM AMONG MATERIALS SATISFYING SAME CONDITIONS
TECHNICAL CONDITION RULE OF PRODUCER, FACTORY, LINE AND EQUIPMENT:	RULE OF CHECKING WHETHER TO SATISFY CONDITIONS THAT PROCESSING CAN BE PERFORMED IN ACTUAL PRODUCER, FACTORY, LINE AND EQUIPMENT AND PROCESSING IS EASY (CHEAP, QUICK)
OPERATIONAL STATE AND SCHEDULE RULE OF PRODUCER, LINE AND EQUIPMENT:	RULE OF PERFORMING DESIGN BASED ON PREMISE THAT CREATION IS PERFORMED BY AVAILABLE PRODUCER, FACTORY, LINE AND EQUIP-MENT FROM AMONG PLURAL PRODUCIBLE PRODUCERS, FACTORIES, LINES AND EQUIPMENT IN CONSIDERATION OF AMOUNT OF BUSINESS OF PRODUCTION SCHEDULE STAGE
PHYSICAL DISTRIBUT-ION RELATED RULE:	RULE SUCH AS RULE OF LIMITING MAXIMUM DIMENSION OF PRODUCT BECAUSE OF PHYSICAL DISTRIBUTION (FOR EXAMPLE, IT BECOMES DIFFICULT TO PERFORM CONVEYANCE BY LAND ON OPEN ROAD WHEN EXCEEDING CETAIN DIMENSION) OR RULE OF REQUIRING SCREW HOLE OF HOOK FOR TRANSPORT (FOR EXAMPLE, HEAVY LOAD)
ENVIRONMENTAL CONTROL-CAPABLE RULE:	RULE OF AVOIDING ENVIRONMENTAL PROBLEMS BY GIVING WARNING IN ORDER TO AVOID ENVIRONMENTAL PROBLEMS SUCH AS CONTENT OF ENVIRONMENTAL CONTROLLED SUBSTANCE IN PRODUCT OR EMISSION OF ENVIRONMENTAL CONTROLLED SUBSTANCE IN MANU-FACTURING PROCESS
AFTER-SALES SERVICE-CAPABLE RULE:	RULE OF CHECKING WHETHER TO HAVE ENGRAVED MARKS ETC. FOR MAKING IT EASY TO REPLACE COMPONENT OR MAKING IT EASY TO GRASP REPLACEMENT COMPONENT SO AS TO EASE AFTER-SALES SERVICE AFTER PRODUCT IS DELIVERED TO CUSTOMER
CUSTOMER BASIS-CAPABLE RULE:	RULE OF CHECKING WHETHER TO SATISFY CONDITION NECESSARY TO SURELY OBEY ON A CUSTOMER BASIS THOUGH CONDITION IS NOT PRESENTED EACH TIME AS DESIGN CONDITION OF INDIVIDUAL PRODUCT
ILLEGAL EXPORT PREVENTION RULE:	RULE OF CHECKING WHETHER TO HAVE DESIGN ADAPTED FOR REGU-LATIONS INCAPABLE OF EXPORTING PRODUCT INCLUDING ADVANCED TECHNIQUE DEPENDING ON PARTNER COUNTRY SUCH AS OVERSEA CUSTOMER
PATENT INFRINGEMENT PREVENTION RULE:	RULE OF CHECKING WHETHER TO HAVE DESIGN FOR PREVENTION IN ORDER TO PREVENT DESIGN IN CONFLICT WITH PATENT OF COMPETITOR
ELECTRONIC DATA SYSTEM ADAPTATION RULE:	RULE OF CHECKING NAME NUMBERING, ACCURACY SPECIFICATION OF CAD DATA, ETC. AS TO WHETHER TO ADAPT TO SENDING AND RECEIVING OF IN-HOUSE OR CUSTOMER ELECTRONIC DATA SUCH AS FILE NAME OF DATA, DATA FORMAT WHEN DESIGN OUTCOMES ARE ELECTRONIC DATA OF CAD ETC.

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FIG. 10

NAME NUMBER	ITEM ID	DETERMINATION ITEM	DESIGN VALUE AND PROBLEM AVOIDANCE RULE	DESIGN VALUE	REFERENCE VALUE	AUTOMATIC DETERMINATION	FINAL DETER-MINATION	REASON
6304	DG001	GROOVE RADIUS IS IMPROPER	$RA = DA * 55 / 100$	11.0	11.0	OK	OK	
6304	DG002	BALL DIAMETER IS TOO LARGE	$DA <= (D - SD) / 2 * 0.6$	20.0	24.0	OK	OK	
6304	DG003	BALL DIAMETER IS TOO SMALL	$DA > = (D - SD) / 2 * 0.4$	20.0	16.0	OK	OK	
608	DG001	GROOVE RADIUS IS IMPROPER	$RA = DA * 55 / 100$	33.0	33.0	OK	OK	
608	DG002	BALL DIAMETER IS TOO LARGE	$DA <= (D - SD) / 2 * 0.6$	36.1	36.0	NG	OK	FACTORY
608	DG003	BALL DIAMETER IS TOO SMALL	$DA > = (D - SD) / 2 * 0.4$	36.1	24.0	OK	OK	

OK BY CONFERENCE WITH FACTORY

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FIG. 11

DESIGN CONDITION INPUT OF BEARING	
HOUSING OUTSIDE DIAMETER UD:	60.0
HOUSING WIDTH UB:	20.0
SHAFT DIAMETER SH:	20.0 NEXT

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FIG. 12

DESIGNER DISCRETION PARTICULAR INPUT		
BEARING NAME NUMBER:	6200	
BALL DIAMETER DA:	16.0	
	RETURN	NEXT

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FIG. 13

DESIGN RESULT

NAME NUMBER: [　　]

SD: [　　]

D: [　　]

B: [　　]

D1: [　　]

D2: [　　]

DA: [16.0] [HELP]

RA: [　　]

DE: [　　]

DN: [　　]

[RETURN] [NEXT]

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FIG. 14

DESIGN HELP

NAME NUMBER: 6200 ID: DG002 DETERMINATION ITEM: BALL DIAMETER IS TOO LARGE ADVICE: DECREASE BALL DIAMETER [OK]

NAME NUMBER	CONDITION RULE	DESIGN VALUE	REFERENCE VALUE	AUTOMATIC DETERMINATION	FINAL DETERMINATION	SPECIAL OK REASON
6304	DA<=(D − SD)/2 * 0.6	20.0	24.0	OK	OK	
608	DA<=(D − SD)/2 * 0.6	36.1	36.0	NG	OK	CONFERENCE WITH FACTORY

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FIG. 15

DESIGN OK/NG DETERMINATION

ITEM ID	DETERMINATION ITEM	DESIGN VALUE AND PROBLEM AVOIDANCE RULE	DESIGN VALUE	REFERENCE VALUE	AUTOMATIC DETERMINATION	FINAL DETERMINATION	REASON
DG001	GROOVE RADIUS IS IMPROPER	RA = DA * 55 / 100	5.5	5.5	OK	OK	
DG002	BALL DIAMETER IS TOO LARGE	DA < = (D − SD) / 2 * 0.6	10.0	12.0	OK	OK	
DG003	BALL DIAMETER IS TOO SMALL	DA > = (D − SD) / 2 * 0.4	10.0	8.0	OK	OK	

THE NUMBER OF OKS: 3   THE NUMBER OF NGS: 0

RETURN   NEXT

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FIG. 16

```
┌─────────────────────────────────┐
│         PRODUCT DESIGN          │
└─────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────┐
│   MANUFACTURING PROCESS DESIGN  │
└─────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────┐
│  INTERMEDIATE COMPONENT DESIGN  │
└─────────────────────────────────┘
                 │
                 ▼
┌─────────────────────────────────┐
│    MANUFACTURING LINE DESIGN    │
└─────────────────────────────────┘
```